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STANDARD FREQUENCY RADIO-SIGNAL TRANSMISSIONS, MARCH TO JUNE

The Bureau of Standards transmits, twice a month, radio signals of definitely announced frequencies for use by the public in standardizing frequency meters (wave meters) and transmitting and receiving apparatus. The signals are transmitted from the bureau station WWV, Washington, D. C., and from station 6XBM, Stanford University, Calif.

The transmissions are by continuous-wave radiotelegraphy. The signals have a slight modulation of high pitch which aids in their identification. A complete frequency transmission includes a "general call," a "standard frequency signal," and "announcements." The "general call" is given at the beginning of the eight-minute period and continues for about two minutes. This includes a statement of the frequency. The "standard frequency signal" is a series of very long dashes with the call letters (WWV or 6XBM) intervening. This signal continues for about four minutes. The "announcements" are on the same frequency as the "standard frequency signal" just transmitted and contain a statement of the frequency. An announcement of the next frequency to be transmitted is then given. There is then a four-minute interval while the transmitting set is adjusted for the next frequency.

The signals can be heard and utilized by stations equipped for continuous-wave reception at distances within about 500 to 1,000 miles from the transmitting stations. Information on how to receive and utilize the signals is given in Letter Circular No. 171, which may be obtained on application from the Bureau of Standards, Washington, D. C. Even though only a few points are received, persons can obtain as complete a wave-meter calibration as desired by the method of generator harmonics, information on which is given in the letter circular.

The schedule of standard frequency signals from both the Bureau of Standards and Stanford University is as follows:

Schedule of Frequencies in Kilocycles

[Approximate wave lengths in meters in parentheses]

Time[1]	Mar. 20	Apr. 5	Apr. 20	May 5	May 20	June 5	June 21
10 to 10.08 p. m.	1,500 (200)	3,000 (100)	125 (2,400)	300 (1,000)	550 (545)	1,500 (200)	3,000 (100)
10.12 to 10.20 p. m.	1,650 (182)	3,300 (91)	133 (2,254)	315 (952)	630 (476)	1,650 (182)	3,300 (91)
10.24 to 10.32 p. m.	1,800 (167)	3,600 (83)	142 (2,097)	345 (869)	730 (411)	1,800 (167)	3,600 (83)
10.36 to 10.44 p. m.	2,000 (150)	4,000 (75)	155 (1,934)	375 (800)	850 (353)	2,000 (150)	4,000 (75)
10.48 to 10.56 p. m.	2,200 (136)	4,400 (68)	166.5 (1,800)	425 (705)	980 (306)	2,200 (136)	4,400 (68)
11 to 11.08 p. m.	2,450 (122)	4,900 (61)	205 (1,463)	500 (600)	1,130 (265)	2,450 (122)	4,900 (61)
11.12 to 11.20 p. m.	2,700 (111)	5,400 (55)	200 (1,153)	600 (500)	1,300 (231)	2,700 (111)	5,400 (55)
11.24 to 11.32 p. m.	3,000 (100)	6,000 (50)	315 (952)	666 (450)	1,500 (200)	3,000 (100)	6,000 (50)

[1] Eastern standard time for WWV, Washington, D. C.; Pacific standard time for 6XBM, California.

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MEASURING THE RATE OF A TUNING FORK

In connection with absolute electrical measurements, it has been necessary to develop a very accurate method of measuring the rate of a tuning fork. In this method the rate of the fork is compared with the period of a gravity pendulum as used by the Coast and Geodetic Survey. The rate of the tuning fork can be determined with an accuracy of 1 part in 100,000 in about 10 seconds.

One of the interesting applications of this method has been in the determination of the effect of amplitude and temperature on the free vibration rate of two tuning forks, one of a good grade of machine steel and the other of a special nickel steel alloy known as " elinvar." The temperature coefficient of the steel fork is about 1 part in 10,000 per degree, whereas with the enlivar fork the temperature coefficient is only 1 part in 100,000 per degree. However, the steel fork showed very little change in frequency with change in amplitude. When the amplitude of the end of the prongs varied from 2 mm to ½ mm, the change in rate was not measureable, which means that it was less than 1 part in a 100,000. With the elinvar tuning fork, however, there was an appreciable change in the rate of the fork as the amplitude changed, there being an increase of about 10 parts in 100,000 when the amplitude decreased from 2 mm to ½ mm. As the forks are practically of identical dimensions, it is difficult to say what caused this difference in behavior. A further study of this question is now in progress.

SPECTROSCOPIC INVESTIGATIONS

In order to extend the comparison of wave lengths of absorption lines in the solar spectrum with those of emission lines produced in the laboratory, 22 interferometer spectrograms of calcium, titanium, manganese, and nickel have been obobtained with vacuum arcs of these metals. The wave lengths will be measured relative to neon standards.

Analysis of complex spectral structures has been advanced by the discovery of new terms in the spark spectrum of zirconium and by deduction of the first regularities in the arc spectrum of iridium. A clue to the latter was obtained from absorption observations in the underwater spark spectrum. It appears that the normal state of the iridium atom is described by a doublet-D spectroscopic term. Complete wave-number lists of iridium and osmium have been computed.

The results of the bureau's investigations on spectral structures for elements of the second long period and the theoretical interpretation of these were reported at the joint meeting of the Optical Society of America and the American Physical Society at Montreal.

SPECTRAL FILTERS

Many substances, such as glass, crystals, dyes, solutions, etc., exhibit the well-known property of absorbing certain regions of the spectrum while transmitting other parts more freely. Such selective absorption in the visible gives rise to the sensation of color. When for any reason in spectral analysis it is not feasible to isolate the desired regions by means of the spectrometer, filters may often be successfully used. Their advantages consist in their simplicity and conservation of energy. They do not, of course, afford the fine analysis possible with the spectrometer.

One writer on the subject states: "The use of light-filters for all scientific purposes has increased greatly of late years. Physicists, astronomers, chemists, doctors, all make use of them to obtain monochromatic rays of light. Botanists employ them to study the influence of light of various colors on plant life * * *, and it may be said with full justification that at the present time there is no field where light-filters are not employed."

An attempt has been made by the bureau, in a paper recently submitted to the Journal of the Optical Society of America and Review of Scientific Instruments, to give a compilation of data which may be of value to those contemplating the use of filters. It should fill the needs of those who ask the Bureau of

Standards for such information. Its scope includes the spectral regions commonly known as the ultra-violet, visible and infra-red, and includes suggestions as to the proper filters to use for isolating any desired region. However, the special filters used in photometry, photography, and pyrometry will be found described in papers on those subjects and are not particularly noted in the present paper.

The data are illustrated with five figures, and a bibliography of 45 references will enable a more detailed study to be made by those interested.

INTERCOMPARING WEIGHTS

Some time ago there was worked out in the mass section of the bureau a new relatively short series of observations for intercomparing weights in a group consisting of two weights of 2 mg. and three weights of 1 mg. The computations apply equally well to any other denominations having the ratio of 2 to 1, but the solution is especially useful for the small weights of analytical and assay sets. From a large number of possible combinations there were selected nine observations for which the least square solution gave numerically simple results and which included groupings of weights that were symmetrical enough so that the values of all weights would be about equally affected by ordinary errors of observation. A new two-sheet computation form has been developed for this series.

DRAWINGS OF THERMAL EXPANSION EQUIPMENT

Blue prints are available as loans to laboratories wishing to install expansivity equipment of the type used by the expansivity section of the Bureau of Standards. These give details of construction for the heating or cooling furnaces and the comparator used in making tests over the range −150 to +1,000° C. The design is, perhaps, more precise than most laboratories would care to install; however, for the highest precision (about 0.1 per cent) and for research investigation it will be found quite satisfactory. A general description of the method and equipment is included in the forthcoming paper, Measurements of the Thermal Expansion of Fused Silica, by Souder and Hidnert of this bureau.

TESTS OF METALS AT HIGH TEMPERATURES

Objections recently raised to the customary high temperature tension tests, to the effect that these do not give useful information to engineers for design of equipment for high temperature service, has made it advisable to study the behavior of typical industrial alloys when subjected for long periods to static stresses at various temperatures. Such tests were recently completed at the bureau on three steels differing widely in chemical composition and physical properties. While giving a fairly complete picture of "creep" or "flow" under sustained loads and a direct determination of load-carrying ability for certain types of service, they require considerable time and are expensive. It, therefore becomes important to seek a relation with tests which may be carried out in a relatively short time.

Correlation of sustained loading and ordinary tension tests on these three steels gave some useful relations by which a rapid approximation of load-carrying ability could be made, but this appeared dependent to some extent upon the accuracy of the equipment, and to better study this question a special extensometer was constructed by which it is possible to measure at various temperatures strain of the order of a few millionths of an inch.

The results of this work will, be described in a report to be presented at the annual meeting of the American Society for Testing Materials in June, 1926.

HIGH PHOSPHORUS CAST IRON

The renewal of sample 7b of high phosphorus cast iron is now ready for distribution with a provisional certificate. The price of this standard is $2.50 per sample of 150 g.

SOIL CORROSION OF PIPE

On March 29 the bureau will begin the second uncovering of soil-corrosion specimens buried in various sections of the

country. The pipe samples have now been in the ground about four years. Samples of bituminous and metallic coatings which have been buried two years will also be removed and a few additional specimens of metals and coatings will be buried.

The previous examination of specimens indicated that soil conditions largely determined the character as well as the amount of corrosion. For this reason those interested in corrosion of underground structures have been urged to study soil conditions as well as metals. Those desiring to be present when the specimens are uncovered should communicate with the Bureau of Standards.

SEASONAL OPERATION IN CONSTRUCTION INDUSTRY

The amount of contracts awarded during the fall and winter months has been the largest on record and is apparently due in substantial measure to consistent efforts to promote winter building, in which the Department of Commerce has cooperated. Actual building operations have proceeded at a very high rate for the season, except where outdoor work has been held up on account of severe weather. Comparative figures of contracts awarded in 36 eastern States are given below.

Contracts awarded in 36 Eastern States

[In millions of dollars]

Month	Season	
	1924–25	1925–25
November	380	465
December	328	511
January	297	457
February (3 weeks)	212	254

In view of these large contracts it is probable that time lost in getting operations under way during the first two months of spring will be unusually small. The bureau's study of seasonal construction showed that it was customary for a large proportion of building-trades workers to be idle in April, May, and often June, even though there might be a considerable showing of new jobs commencing.

REDUCTION IN VARIETY OF GRINDING WHEELS

In June, 1925, the simplification committee of the manufacturers of grinding wheels requested the division of simplified practice to call a general conference of manufacturers, distributers, and users to consider the tentative elimination of waste schedule which the committee had prepared. This schedule was the result of a survey of the industry to determine the relative volume of demand for the various sizes and shapes of wheels.

The combined efforts of this general conference resulted in a reduction from 715,200 varieties to 255,800 varieties of grinding wheels, corresponding to an elimination of 64.23 per cent. It is expected that this simplified list of sizes will offer greater convenience and saving to all concerned than was possible with the former wide variety, and it is hoped that the estimated saving of $5,000,000 a year to the industry will actually be achieved.

The conference decided that the simplified list should become effective as applying to new production January 1, 1926, and that every effort should be made to clear current orders and existing stocks of the eliminated sizes before July 1, 1926.

PREPARATION OF THE ENDS OF CONCRETE COMPRESSION CYLINDERS

The compressive strength of concrete mixtures is generally determined by breaking 6 by 12 inch test cylinders at the age of 7 and 28 days. In order to obtain a true compression failure, it is necessary to have the ends of the cylinders true planes perpendicular to the axis of the cylinder. Considerable time and attention are required to secure this condition. Heretofore the bureau has used a steel cylinder mold for casting the cylinder. The inside circumference of the mold is machined, and the mold rests on a flat steel machined plate which gives a true plane at the bottom. About four hours after the cylinder was cast the top was brushed and a cap of neat cement paste about $\frac{1}{16}$ to $\frac{1}{8}$ inch thick placed on it. After remaining in the mold 24 hours the cap was scraped

to a true plane with a steel straightedge, the top of the mold being used for a guide during the scraping operation.

With the object of lessening the time and labor in preparing the ends of the cylinders the bureau purchased a surfacing machine to reduce the upper surface to a true plane. The machine proper consists of a standard to which is attached a vertical electrically driven grinding wheel. The abrasive wheel is cup shaped, approximately 18 inches in diameter, with a cutting surface about 4 inches wide around the circumference and about 4 inches thick. The cylinders are held by a strap iron in a V block mounted on a horizontal steel platform. The platform is carried on a rocker motion which allows the cylinder to pass back and forth across the grinding surface of the wheel, and a screw feed permits any given amount of the cylinder to be fed to the grinding surface. The V block can be turned through 180°, so that both ends can be trued without removing the cylinder.

Recently some tests were run to obtain a comparison between the compressive strength of a concrete obtained from cylinders capped in two ways with the use of the machine and that from cylinders capped according to the usual methods. A 1 : 2 : 4 by volume gravel concrete having a flow of 100 was used to prepare the cylinders. In all cases the standard methods of molding the cylinders were carried out with the exception of preparing the ends. The specimens were cured in a damp atmosphere, and five of each kind were broken at the ages of 7 and 28 days.

The methods of capping were as follows: (*a*) Molds filled level full with the concrete and the top of test specimen ground to a true plane just before breaking. (*b*) The usual bureau laboratory method outlined above. (c) Specimens capped as in (*b*), but instead of the scraping operation the ends ground just before breaking. (*d*) A neat cement cap placed on the specimens approximately 24 hours before breaking. The results obtained are given in the following table:

Age	Character of determination	Variation with different methods of capping			
		A	B	C	D
7 days	Average deviation from mean	*Per cent* 3.6	*Per cent* 2.6	*Per cent* 4.0	*Per cent* 5.0
	Maximum deviation from mean	5.6	4.3	10.0	7.2
	Strength based on B as 100 per cent	112	100	102	120
28 days	Average deviation from mean	4.5	4.2	3.1	6.6
	Maximum deviation from mean	9.4	7.6	6.8	12.8
	Strength based on B as 100 per cent	102	100	102	107

The results of the preliminary tests show that the same strengths are obtained for the same concrete with the use of the machine as with the usual method of capping, and the variation from the mean average strength is within the range of usual laboratory results. The merit of the machine is that a true flat surface can be ground at either or both ends of the cylinders at a great saving of time as compared with the former scraping method.

FINENESS OF HYDRATED LIME

The bureau has recently undertaken an investigation to obtain more information on the fineness of hydrated lime. It is known that the majority of the hydrates can be screened through a 200 or even a 350 mesh screen, but beyond this point the size of the material has been a much-debated question.

The first step in the work was to find a method of separating the different size particles of the hydrated material. Various elutriation and flotation methods were considered, and it was decided to try the air elutriation method, used and developed by the bureau for determining the fineness of Portland cement. This method was accepted because other methods employed liquids as elutriation mediums which, if used with hydrated lime, would require the use of nonaqueous liquids and, in addition to this, the methods did not appear to be entirely satisfactory for accurate separations.

Preliminary determinations with the apparatus described indicated that from 83 to 90 per cent of hydrated lime is finer than 0.02 mm (20μ) in diameter. Separations were made with other equipment capable of separating material less than 0.01 mm in diameter, and it was found that from 70 to 75 per cent of the material was finer than 0.01 mm.

Measurements of this material were made with a microscope employing a 4 mm objective. It could be readily seen, when measurements were being made, that the larger particles were formed from agglomerations of smaller particles that appeared to be about 0.001 mm in diameter. There was a considerable quantity of the particles of this size on the slides, but it was impossible to measure, with any degree of accuracy, particles less than 0.003 mm in diameter.

The presence of the smaller particles and agglomerations of them raises a question relative to the fineness of the hydrate. Whether or not the majority of the material can be separated into particles of 0.001 mm or less in diameter is still to be determined. Plans have been made to modify the method with such an object in view. However, it has been determined that approximately 85 to 90 per cent of hydrated lime is finer than 0.02 mm in diameter, and that 75 per cent is finer than 0.01. The sizes of these particles are equivalent to material passing theoretical 750 and 1,500 mesh screens for the 0.02 and 0.01 mm, respectively.

DRYING OF CLAYS

Data of possible scientific interest and fundamental importance have recently been obtained in this investigation by departing somewhat from the conventional method of studying drying. The study was made to determine rate of water flow and shrinkage and water-concentration gradients within a clay body at various stages of drying. Specimens were used in which evaporation could take place from one face only.

Preliminary work has been restricted to two clays, the one (KK) a surface clay which can be dried very easily without forming cracks or other typical "drying failures"; the other a low-grade fire clay (JJ) which is very difficult to dry.

It was found that the total shrinkage of the surface clay was about 60 per cent of that of the fire clay, and that this shrinkage was completed at a temperature of 84° C., while the fire clay continued to shrink at 107° C.; also, the shrinkage of the surface clay was practically complete when 40 per cent of the water had been evaporated, while the shrinkage in the fire clay continued until about 85 per cent had been evaporated.

It was also found that (*a*) both the shrinkage gradient (that is, the difference in shrinkage between the face of the specimen and the interior) and the water-concentration gradient (that is, the difference between the per cent of water at the surface of the specimen and in the interior) was appreciably greater during the early stages of drying in the case of the surface clay; and (*b*) that evaporation from the surface clay would reach equilibrium comparatively rapidly under given conditions of temperature and humidity.

RECLAIMED RUBBER

The use of reclaimed rubber in the treads of pneumatic tires has been investigated at the bureau, and the results which have been published in Technologic Paper No. 294 show that tire treads in which 25 per cent of the normal rubber content had been replaced by reclaimed rubber gave an average service of about 7,000 miles on the road. It is probable that further experimentation involving different grades of reclaimed rubber and different compounds will lead to still better results. It is planned to carry out a similar investigation on the use of reclaimed rubber in the carcass of tires. This is the part in which the design is most exacting and in which a small change may have a large influence on the tire's life. For this reason manufacturers have hesitated to use any material other than new rubber. However, because of the high cost of new rubber, considerable experimental work is being carried on with a view to replacing some of it with reclaimed rubber. Preliminary dynamometer and endurance tests which the bureau has conducted of tires manufactured in

this manner indicate that the use of reclaimed rubber may be entirely feasible. However, it appears that the incorporation of reclaimed rubber in a scientific manner is of great importance, and that careful consideration must be given to proper balancing of the various ingredients of the compound. Inasmuch as the carcass contains a large part of the rubber used in a tire, a very great saving in new rubber would result from the substitution of even a small percentage of reclaimed rubber.

RAYON MADE WITH HOLLOW FILAMENTS

One of the features of rayon which has been the subject of much concern to knit goods manufacturers is the covering power of the yarn. Recently, in supplementing tests previously made on rayons used in the underwear industry, several samples of celta (macaroni) rayon (a foreign product) were studied by the research associate of the Associated Knit Underwear Manufacturers of America stationed at the bureau. It was found that this product was made with a hollow filament which permits a greater number of filaments per unit weight length than would be the case with a solid filament. This may give it an advantage in the manufacture of knit underwear because it can be made either with a larger number of filaments or with a larger filament and still not be objectionable on account of weight. This is of particular interest, because one criticism of rayon has been that if the covering power obtained by other fibers is provided a very heavy fabric results.

Viewed under the microscope, cross sections of this type of rayon appear like flattened tubes. It was found that there were 40 filaments in the 150 denier celta rayon as compared with 16 to 26 filaments in other types of rayons which were studied previously. The strength qualities compared favorably with other types.

A COMPARATIVE STUDY OF PAPER FILLERS

Fillers, as the term is used in the paper industry, are finely divided substances added to paper to fill up the spaces between the fibers composing the sheet. These fibers lie in a tangled mat separated by relatively large spaces. A good filler has sufficient range of particle sizes to fill the interstices, and at the same time it gives the sheet certain physical characteristics (opacity, body, finish) especially desirable in some grades of paper. In fact, in the case of book papers, fillers have come to be regarded as a necessary constituent because of the improvement in printing quality which they bring about.

Commercial paper fillers, consisting of asbestine, talc, clay, crown filler, and gypsum, have been studied as to their comparative paper-making value, using the semicommercial paper mill of the bureau. The percentage of filler added was varied, the amounts being 10 and 20 per cent, by weight, of the beater furnish. The paper produced was tested for weight, strength, color, opacity, finish, degree sized (nonabsorbency), and amount of filler retained.

Asbestine, talc, and clay were found to have similar paper-making properties. Crown filler and gypsum, however, being soluble in water, yielded somewhat different results from the other (insoluble) fillers.

Retention was less for the soluble materials and, in general, the differences noted in the characteristics of the papers were due chiefly to the difference in the amount of filler retained. The sizing process and the other paper-making operations were not adversely affected by any of the fillers employed. Complete details of this study are given in Technologic Paper, No. 301, now available. A Comparative Study of Paper Fillers, by M. B. Shaw and G. W. Bicking (Government Printing Office, Superintendent of Documents, Washington, D. C., price 10 cents).

FEBRUARY, 1926, PUBLICATIONS

Additions to "Supplementary List of Publications of The Bureau of Standards" (Beginning July 1, 1925)

OUTSIDE PUBLICATIONS

Chemistry in the metallurgical division of the Bureau of Standards; H. W. Gillett, Journal Chemical Education, Vol. 3, No. 2, p. 148; February, 1926.

Dimensional changes accompanying the phenomena of tempering and aging tool steels; H. Scott; Transactions, American Society for Steel Treating; Vol. 9, No. 2, p. 277; February, 1926.

Relations between rotatory power and structure in the sugar group. XII. The preparation and properties of pure alpha-methyl d-Lyxoside; F. P. Phelps and C. S. Hudson; Journal, American Chemical Society; Vol. 48, p. 403, 1926.

The relation between metallurgy and atomic structure; Paul D. Foote; Fifth Annual Lecture of the Institute of Metals Division, American Institute of Mining and Metallurgical Engineers; Preprint 1547–D. Issued with Mining and Metallurgy, February, 1926.

Circular on nickel electrotyping solutions; W. Blum and J. H. Winkler; Published by International Association of Electrotypers.

Scientific Papers

S517. A special camera for photographing cylindrical surfaces; Raymond Davis. Price, 10 cents.

S518. Metallographic etching reagents, III: For alloy steels; Edward C. Groesbeck. Price, 25 cents.

Technologic Papers

T300. Development of a standard bending test for rope yarns; Charles W. Schoffstall and Robert C. Boyden. Price, 10 cents.

T302. Investigation of synthetic tanning materials; Edward Wolesensky. Price, 15 cents.

Circulars

C283. United States Government master specification for stitches, seams, and stitching. Price, 20 cents.

C296. Research associates at the Bureau of Standards. Price, 10 cents.

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